

## **A METHOD AND DEVICE FOR CONTROLLING DRILLING FLUID PRESSURE**



### **CROSS-REFERENCE TO RELATED PATENT APPLICATIONS**

This Application is a national stage entry of application PCT/NO2004/000359, filed on 11/24/2004, the contents of which are incorporated herein by reference in their entirety. Norway priority Patent Application 20035257, filed on 11/27/2003, from which the aforementioned PCT application claims priority, is likewise incorporated herein by reference in its entirety. Applicant claims priority to the aforementioned Norwegian application.

### **BACKGROUND OF THE INVENTION**

During drilling operations (e.g. for petroleum production), the pressure head of drilling fluid present in a borehole and up to a platform, may cause the liquid pressure in the lower portion of the borehole to become too high.

Excessive drilling fluid pressures may result in the drilling fluid causing undesirable damage to the formation being drilled (e.g. through drilling fluid penetrating into the formation).

The formation may also include special geological formations (saline deposits etc.) that require the use of special drilling fluid in order to stabilise the formation.

According to prior art, it is difficult to reduce the specific gravity of the drilling fluid in order to reduce the pressure to an acceptable level. In many cases, it has proven difficult to achieve a sufficient reduction in the specific gravity of the drilling fluid without causing an unacceptable degree of change in the physical properties of the drilling fluid, such as viscosity.

It is known to dilute the drilling fluid in a riser in order to reduce the drilling fluid pressure (see US Patent No. 6,536,540).

## SUMMARY OF THE INVENTION

This invention regards a method of controlling drilling fluid pressure. More particularly, it regards a method of controlling the drilling fluid pressure in an underground borehole during drilling of wells from a fixed offshore platform. The invention also regards a device for practicing the method.

When drilling from floating installations, the drilling fluid pressure in the well and the weight of the riser may be reduced by pumping drilling fluid out of the riser at a level below the surface of the sea. Thus US Patent Nos. 4,063,602 and 4,291,772 concern drilling vessels provided with a return pump for drilling fluid. When using such teachings according to these patents, it is difficult to monitor the volumetric flow in the borehole, as the annulus above the drilling fluid in the liner, or alternatively riser, is filled with gas, typically air. This gas-filled annulus may fill up with or become drained of drilling fluid without being easily observed.

Some embodiments of the present invention remedy or reduce at least one of the disadvantages of prior art.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic view of a fixed drilling rig provided with a pump for the returning drilling fluid, the pump being coupled to a riser section near the seabed and the riser section being filled with a fluid of a different density than that of the drilling fluid.

Figure 2 is a schematic similar to Figure 1, but where the drilling fluid fills a greater part of the riser section.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As will be described in greater detail below, with the physics being briefly discussed here, referring to Figures 1 and 2, when drilling from fixed platforms (drilling devices), a conductor is first driven into the seabed. When drilling a

borehole 15 from a fixed drilling device, drilling fluid is pumped through a drill string 16 down to a drilling tool. The drilling fluid serves several purposes, of which one is to transport drill cuttings out of the borehole. Efficient transport of drill cuttings is conditional on the drilling fluid being relatively viscous.

The drilling fluid flows back through the annulus 30 between the borehole wall, the liner 14 mentioned above and the drill string 16, and up to the drilling rig, where the drilling fluid is treated and conditioned before being pumped back down to the borehole. In many cases, this will result in a head of pressure that is undesirable.

By coupling a pump 20 to the liner 14 near the seabed, the returning drilling fluid can be pumped out of the annulus 30 and up to the drilling rig. According to the invention, the annular volume above the drilling fluid is filled with a riser fluid. Preferably, the density of the riser fluid is less than that of the drilling fluid.

The drilling fluid pressure at the seabed may be controlled from the drilling rig by selecting the inlet pressure to the pump 20. The height  $H_1$  of the column of drilling fluid above the seabed depends on the selected inlet pressure of the pump, the density of the drilling fluid and the density of the riser fluid, as the inlet pressure of the pump is equal to:

$$P = H_1 \times \gamma_b + H_2 \times \gamma_s$$

Where:

$\gamma_b$  = the density of the drilling fluid,

$H_2$  = the height of the column of riser fluid, and

$\gamma_s$  = the density of the riser fluid.

$H_1$  and  $H_2$  together make up the length of the riser section from the seabed and up to the deck of the drilling rig.

Filling the liner annulus with a riser fluid allows continuous flow quantity control of the fluid flowing into and out of the borehole. Thus, it is relatively easy to detect a phenomenon, such as, for example, drilling fluid flowing into the drilling formation.

It is furthermore possible to maintain a substantially constant drilling fluid pressure at the seabed, also when the drilling fluid density changes.

Choosing another inlet pressure to the pump will immediately cause the heights  $H_1$  and  $H_2$  to change according to the new pressure.

If so desired, the outlet 17 from the annulus 30 to the pump 20 can be arranged at a level below the seabed, by coupling a first pump pipe to the annulus at a level below the seabed.

In order to prevent the drilling fluid pressure from exceeding an acceptable level (e.g. in the case of a pump trip), the riser may be provided with a dump valve. A dump valve of this type can be set to open at a particular pressure for outflow of drilling fluid to the sea.

The following describes a non-limiting example of a preferred method and device illustrated in the accompanying drawings, in which, as noted above, Figure 1 is a schematic view of a fixed drilling rig provided with a pump for the returning drilling fluid, the pump being coupled to the riser section near the seabed and the riser section being filled with a fluid of a different density than that of the drilling fluid; and Figure 2 is similar to Figure 1, but here the drilling fluid fills a greater part of the riser section.

In the drawings, reference number 1 denotes a fixed drilling rig comprising a support structure 2, a deck 4 and a derrick 6. The support structure 2 is placed on the seabed 8 and projects above the surface 10 of the sea.

A riser section 12 of a liner 14 extends from the seabed 8 up to the deck 4, while the liner 14 runs further down into a borehole 15. The riser section 12 is provided with required well head valves (not shown).

A drill string 16 projects from the deck 4 and down through the liner 14.

A first pump pipe 17 is coupled to the riser section 12 near the seabed 8 via a valve 18 and the opposite end portion of the pump pipe 17 is coupled to a pump 20 placed near the seabed 8. A second pump pipe 22 runs from the pump 20 up to a collection tank 24 for drilling fluid on the deck 4.

A tank 26 for a riser fluid communicates with the riser section 12 via a connecting pipe 28 at the deck 4. The connecting pipe 28 has a volume meter

(not shown). Preferably, the density of the riser fluid is less than that of the drilling fluid.

The power supply to the pump 20 is via a cable (not shown) from the drilling rig 1 and the pressure at the inlet to the pump 20 is selected from the drilling rig 1. The pump 20 may optionally be driven hydraulically by means of oil that is circulated back to the drilling rig or by means of water that is dumped in the sea.

The drilling fluid is pumped down through the drill string 16 in a manner that is known *per se*, returning to the deck 4 via an annulus 30 between the liner 14 and the drill string 16. When the pump 20 is started, the drilling fluid is returned from the annulus 30 via the pump 20 to the collection tank 24 on the deck 4.

Riser fluid passes from the tank 26 into the annulus 30 in the riser section 12. The height  $H_1$  of the column of drilling fluid above the seabed 8 adjusts according to the selected inlet pressure of the pump 20, as described in the general part of the description.

The volume of riser fluid flowing into and out of the tank 26 is monitored, making it possible to keep a check e.g. on whether drilling fluid is disappearing into the well formation, or gas or liquid is flowing from the formation and into the system.

The invention makes it possible by use of simple means to achieve a significant reduction in the pressure of the drilling fluid in the borehole 15. Figure 2 shows a situation where a higher inlet pressure has been selected for the pump, and where the heights  $H_1$  and  $H_2$  of the fluid columns have changed relative to the situation shown in Figure 1.